1250983

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

November 18, 2004

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: ***60/511,872***
FILING DATE: ***October 16, 2003***
RELATED PCT APPLICATION NUMBER: ***PCT/US04/34270***

Certified by

Jon W Dudas

Acting Under Secretary of Commerce
for Intellectual Property
and Acting Director of the U.S.
Patent and Trademark Office

PROVISIONAL APPLICATION COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION for PATENT under 37 CFR 1.53(c).

Docket No.	IU030137

22582 U.S. PTO 60/511872 101603

INVENTOR(s) / APPLICANT(s)

Last Name	First Name	Middle Initial	Residence (City and Either State or Foreign Country)
Willis	Donald	H.	Indianapolis, IN

TITLE OF THE INVENTION (280 characters max)

Resolution Enhanced Dot Sequential Display

Correspondence Address:
Joseph S. Tripoli
Thomson Licensing, S.A.
P.O. Box 5312
Princeton

Telephone No. (609) 734-6867
Facsimile No. (609) 734-6888

State	NJ	Zip Code	08543-5312	Country	United States of America

ENCLOSED APPLICATION PARTS (check all that apply)

X Specification	Number of Pages	8	**Total Number of Pages = 15**
X Abstract	Number of Pages	1	
X Drawings	Number of Sheets	6	Other: Certificate of Mailing and Acknowledgment Card

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

__ Applicant claims small entity status. See 37 CFR 1.27. __ A check or money order is enclosed to cover the filing fees X The Commissioner is hereby authorized to charge filing fees and credit Deposit Account No. 07-0832	PROVISIONAL FILING FEE AMOUNT ($)	**$160.00**

Respectfully submitted,
Signature: *Patricia A. Verlangieri* Date: October 16, 2003
Typed Name Patricia A. Verlangieri Registration No.: 42,201
Telephone (609) 734-6867

____Additional inventors are being named on separately numbered sheets attached hereto.

PROVISIONAL APPLICATION FILING ONLY

SEND TO: Commissioner for Patents, P.O. Box 1450, Mail Stop: Provisional Patent Application, Alexandria, VA 22313-1450.

1213012_2

CERTIFICATE OF MAILING

Express Mail No.: **EU854419061US**

Deposited: **October 16, 2003**

I hereby certify that the attached correspondence identified below is being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" under 37 CFR 1.10 on the date indicated above and is addressed to:

Mail Stop Provisional Patent Application
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

BARLEY, SNYDER, SENFT & COHEN, LLC

By: Heath Gonsoid
Heather L. Gonsorick

Thomson File: IU030137

RESOLUTION ENHANCED DOT SEQUENTIAL DISPLAY

Field of the Invention

The invention is related to a projection display system and more particularly to such a system having a dot sequential display.

Background of the Invention

Micro-display projection systems using a reflective light engine or imager, such as digital light pulse (DLP) imager, are increasingly utilized in color image or video projection devices (e.g., rear projection television (RPTV)). In an existing projection system, shown in Figure 1, a light source 1, in this case a UHP lamp generates white light (i.e., all color spectrums). Light from the light source 1 passes through a color wheel 2 which has a plurality of dichroic filters, each of which allows a light band of one of the colors: blue, green and red to pass through and reflects light of the other colors. The color wheel 2 is rotated so that a temporal pattern of blue, green, and red light bands pass through the color wheel. The color wheel typically is rotated fast enough to create at least one primary color period for each primary color during each frame of a video image. Rotating the wheel faster, or using multiple filter segments for one or more of the primary colors can produce color separation artifacts that allow the viewer to detect the sequential color nature of the display system. For example, color breakup, also called the rainbow effect, is caused by light passing through a rotating color wheel with colors flashing sequentially and appears as a momentary flash of rainbow-like striping typically trailing bright objects when looking quickly from one side of a viewing screen to the other, or when quickly looking away from the viewing screen to an off-screen object. Additionally, color edge effects appearing as a flash of one of the three primary colors in the sequential color light beam at a leading edge of a moving object across the screen may also produce color separation artifacts.

An integrator 3 receives the light band from the light source 1 that is allowed to pass through the color wheel 2 and directs the light band through relay optics 4 into a total internal reflection (TIR) prism 5. The TIR prism 5 deflects the light band onto an imager 6, such as a DLP imager. The imager modulates the intensity of individual pixels of the light beam and reflects them back through the TIR prism 5 and into a projection lens system 7. The projection lens system 7 focuses the light pixels onto a screen (not shown) to form a viewable image. A color video image is formed by rapid successive matrices of pixels of each of the three colors (blue, green, and red) which are blended by the viewer's eye to form a full color image.

Throughout this specification, and consistent with the practice of the relevant art, the term pixel is used to designate a small area or dot of an image, the corresponding portion of a light transmission, and the portion of an imager producing that light transmission.

The DLP imager 6 comprises a matrix of micro-mirrors, moveable between an angle that reflects light through the TIR prism 5 and into the projection lens system 7 and an angle that deflects the light so that it is not projected by the projection lens system 7. Each micro-mirror reflects a pixel of light of a desired intensity depending upon a succession of angles of that particular micro-mirror which in turn are responsive to a video signal addressed to the DLP imager 6. Thus, in the DLP imager 6, each micro-mirror or pixel of the imager modulates the light incident on it according to a gray-scale factor input to the imager or light engine to form a matrix of discrete modulated light signals or pixels.

Existing DLP imagers, however, suffer from several problems. The color wheel wastes light, as the light having the colors that are reflected is typically lost. Also, color separation or break-up artifacts degrade the image quality of the projection system as described above. Additionally, each micro-mirror may pivot up to twelve times for each of the three color bands for each frame, limiting the frame speed and adversely effecting

mechanical reliability. As such, a system for reducing color separation or breakup artifacts and having improved resolution is needed.

Summary of the Invention

A projection system having a light source, an integrator, a microdisplay and a shifting plate. The integrator is optically coupled to the light source and has a matrix of transmissive portions at an output end. The microdisplay consists of an array of micromirrors, each micromirror being optically coupled to a respective transmissive portion of the integrator output for modulating light incident from the integrator. The shifting plate is optically coupled to the microdisplay output for shifting the microdisplay output at selected time intervals.

Brief Description of the Drawings

The invention will now be described by way of example with reference to the accompanying figures of which:

FIGURE 1 shows a diagrammatic view of a prior art projection system.

FIGURE 2 shows a diagrammatic view of a projection system according the invention.

FIGURE 3 is an end view of the input end of the integrator of Figure 2.

FIGURE 4 is an end view of the output end of the integrator of Figure 2.

FIGURE 5 is an end view of the output end of the integrator showing the filters.

FIGURE 6 is a view of the imager output showing successive color filling.

Detailed Description of the Preferred Emodiment

The invention will now be described in greater detail with reference to the accompanying figures. First, the invention will be described generally with reference to Figure 2. The projection system 10 includes a lamp 12 for transmitting white light being optically coupled to an integrator 20 which outputs light through an imaging lens 30 to a microdisplay 32. Light passes the microdisplay 32 through a shifting plate 34 to a projection lens 36, which outputs images to a screen "not shown". Each of these major components will now be described in greater detail.

The lamp 12 is a high intensity multiple wavelength output lamp which is suitable for use in projection display systems. A suitable lamp 12 for this purpose is a UHP lamp that is well known in the art as a light source for projection displays. Light output of the lamp 12 is coupled to an integrator 20. The integrator 20 is a formed as a rectangular cylinder for directing light output of the lamp toward a microdisplay 32 in a given rectangular aspect ratio and size which corresponds with that of the microdisplay 32. In this embodiment, the integrator 20 has a peripheral surface 26, which has a reflective coating such as a silver coating extending substantially around its entirety. Referring to Figure 3, the input end 22 of the integrator 20 has a similar reflective coating applied selectively to form a transmissive portion 25 through which light from the lamp passes and a reflective portion 23, which reflects light internally within and along the peripheral surface 26. Similarly, referring to Figure 4 the output end 24 is formed to have a reflective portion 27 and plurality of transmissive portions 28. The transmissive portions 28 can be thought of as a plurality of apertures through which light is allowed to pass from the interior through the output end 24. Each transmissive portion 28 has a filter applied thereto for allowing passage of a selected color or band of light while blocking other colors of light from passing therethrough. For example, as shown in Figure 5, filters 29R allows the passage of red light out of the

integrator 20 while filters 29B allows passage of blue light out of the integrator 20 and filters 29G allow the passage of green out of the integrator 20. It can be appreciated by those reasonably skilled in the art therefore that each transmissive portion 28 may be selected to always transmit the same color light by applying selective filters 29 over selected transmissive portions 28. It should be further understood and appreciated that the reflective portions 27 serve to reflect incident light back into the integrator 20 and over the interior surfaces to be eventually redirected once again towards the output end 24 and through transmissive portions 28. This serves to conserve illumination and reduce light attenuation through the integrator 20. Light output from the integrator 20 passes through an imaging lens 30, which is selected and positioned to image the integrator output onto the microdisplay 32.

The microdisplay 32 of this embodiment is a digital light pulse (DLP) microdisplay having a plurality of micromirrors each corresponding to a pixel within the projection system 10. It should be understood that each transmissive portion 28 having a filter 29 applied on its output is selected to illuminate a particular micromirror of the microdisplay 32 always with the same color light. The microdisplay 32 is operated to modulate each pixel with the input video signal as is well known in the art. Pixel output of the microdisplay 32 is then past through a shifting plate 34. The shifting plate 34 consists of a light transmissive material of a selected thickness being angularly oriented to the light path and mounted such that it may be pivoted slightly between several output positions. The shifting plate 34 may be pivoted in order to shift the input image a desired amount, for example one-half or one pixel length on its output. A projection lens 36 receives output from the shifting plate 34 and projects it onto a screen.

As shown in Figure 5, the filters 29 are arranged sequentially such that a red filter 29R is proceeded along a row by a blue filter 29B and then a green filter 29G. The pattern then continues along that row with red, then blue, then green. It should be understood that

the array of Figure 5 is merely illustrative of the sequential nature of the arrangement and that any size array may be created based on the imager and system requirements. The second row begins with a green filter 29G and then proceeds with the same order of colors that being, red, blue, green. Finally, the third row begins with a blue filter 29B and then proceeds with the same pattern, that is green, red, blue thus populating the entire array with filters.

In use, the microdisplay 32 receives a constant color of light at each respective micromirror and then modulates each pixel according to the video input signal. Turning now to Figure 6, a succession is shown of the projection lens input 37 during successive modulation intervals. In these drawings, R indicates a red pixel, B indicates a blue pixel, and G indicates a green pixel. After a first modulation interval, the shifting plate 34 is tilted slightly causing the light incident on the projection lens 36 to shift by a selected pitch, which in this embodiment is two pixel lengths or one micromirror length. In the second modulation interval the pixel positions that had previously been receiving red light will now receive green light and the pixels previously receiving green light will receive blue light. Similarly, those pixels which had been receiving blue light will be receiving red light. In a third modulation time interval the shifting plate 34 is moved once again such that the light shifts another mirror pitch adding the final primary color to each pixel position. Next, the shifting plate 34 shifts the image back by one pixel pitch or half a micromirror pitch and the process is repeated adding pixels within same rows in between the first ones that had been previously illuminated with each of the three primary colors. This has advantageous result of displaying every other row of pixels with twice as many pixels per row as there are micromirrors per row. The shifting plate 24 may then be shifted downward by one pixel to fill in between the rows by repeating the previous two process steps.

In an alternate embodiment, the filters may be removed to have the output of the integrator configured as shown in Figure 4 such that the integrator pass all colors of incident

light through each transmissive portion 28 and a color wheel may be added back into the system and located as in Figure 1. In this embodiment, light colors pass sequentially through the integrator 20 according to the position of the color wheel. The microdisplay 32 modulates an entire array of each color within a modulation interval and then modulates an entire array of the next success color in the successive modulation interval and finally the third color in the next successive modulation interval. This results in each pixel defined by the transmissive portions 28 of the integrator being successively illuminated with each color to form a full color image without moving the shifting plate 34. The shifting plate 34 is then tilted or moved to fill in additional pixels defined by the reflective portions 27 on the integrator output for improved resolution.

The invention advantageously allows an array of micromirrors in a microdisplay to sequentially illuminate a relatively larger array on a projection lens thus improving resolution of the system.

<u>What is Claimed is</u>:

1. A projection system, comprising:

a light source;

an integrator being optically coupled to the light source and having a matrix of transmissive portions at an output end;

a microdisplay having an array of micromirrors, each micromirror being optically coupled to a respective transmissive portion of the integrator output for modulating light incident from the integrator; and,

a shifting plate optically coupled to the microdisplay output for shifting the microdisplay output at selected time intervals.

Abstract

A projection system having a light source, an integrator, a microdisplay and a shifting plate. The integrator is optically coupled to the light source and has a matrix of transmissive portions at an output end. The microdisplay consists of an array of micromirrors, each micromirror being optically coupled to a respective transmissive portion of the integrator output for modulating light incident from the integrator. The shifting plate is optically coupled to the microdisplay output for shifting the microdisplay output at selected time intervals.

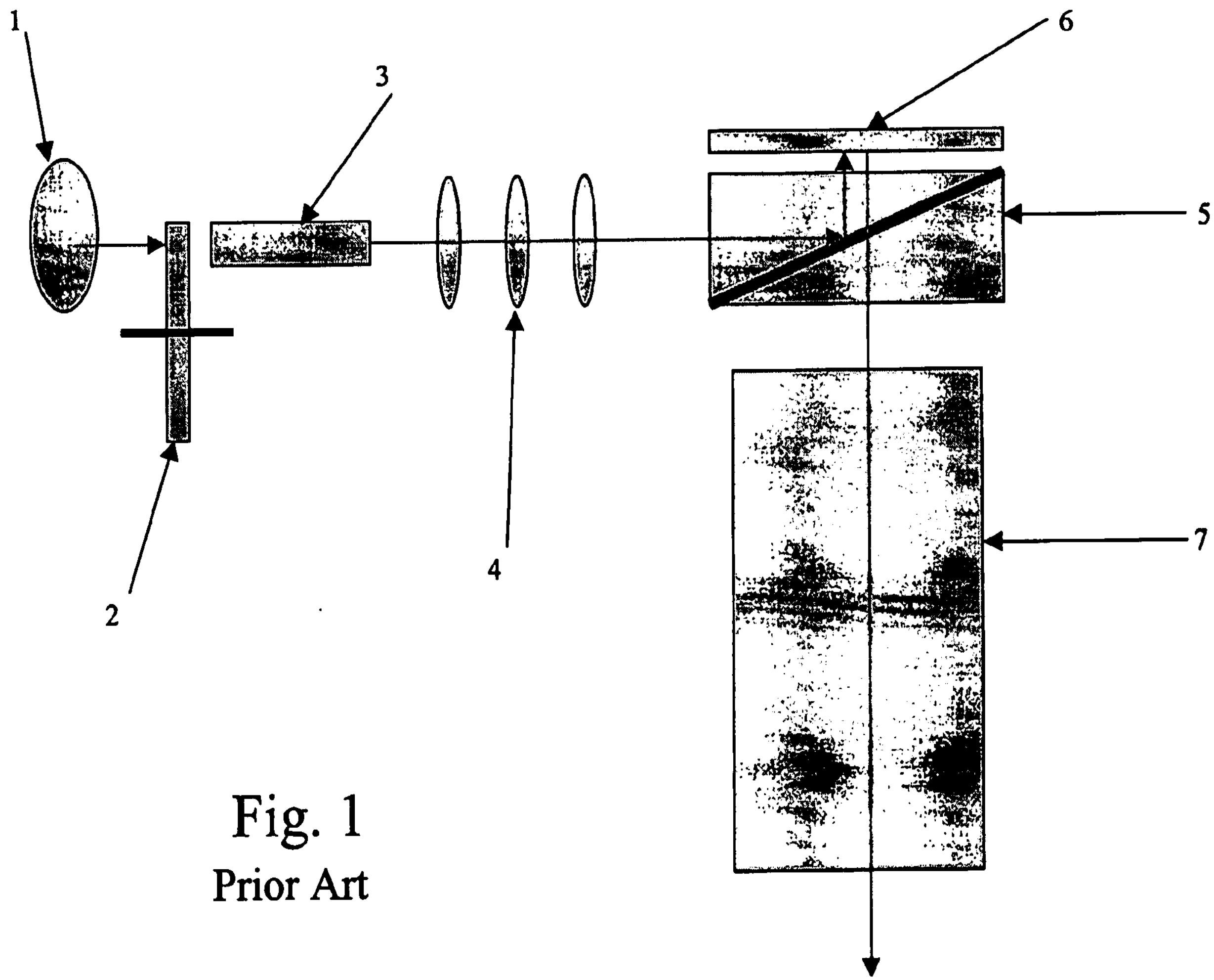

Fig. 1
Prior Art

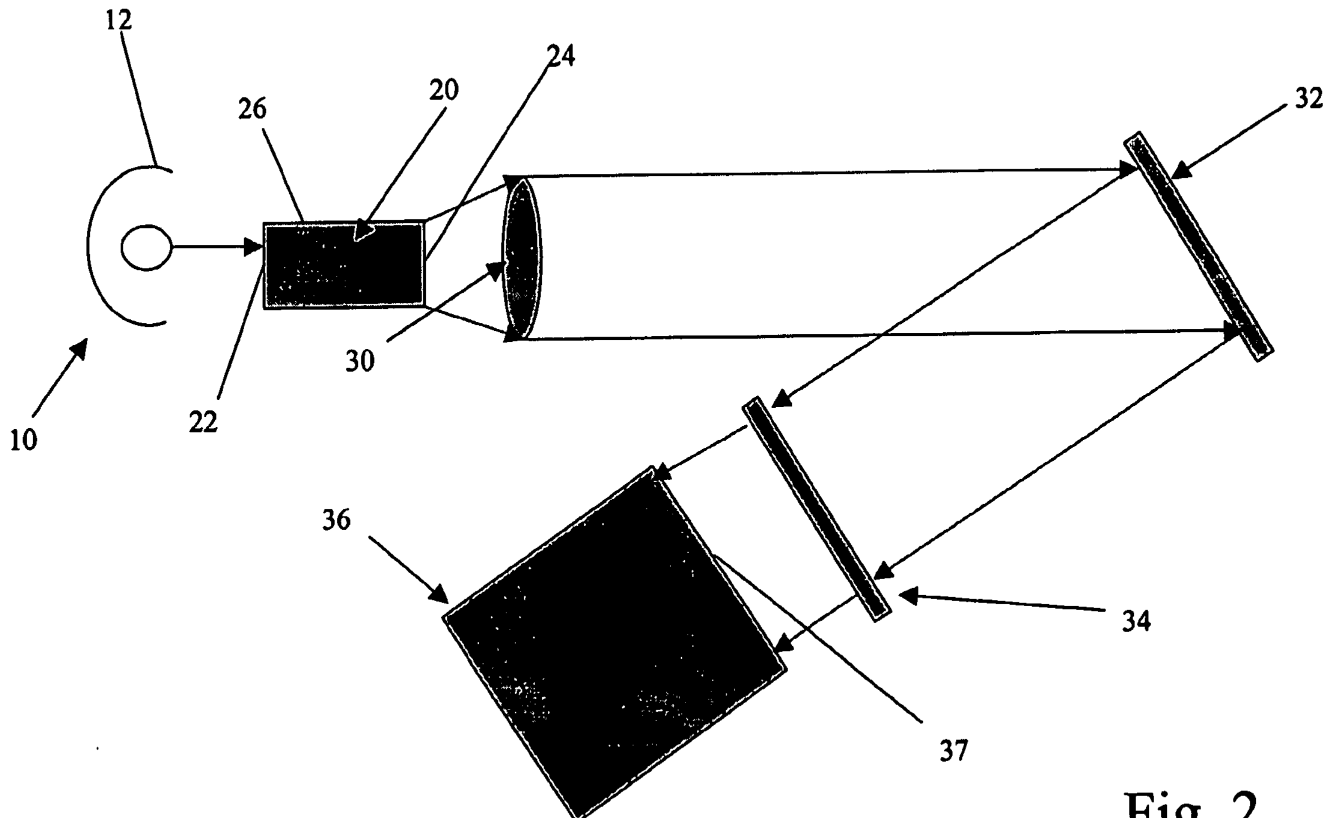

Fig. 2

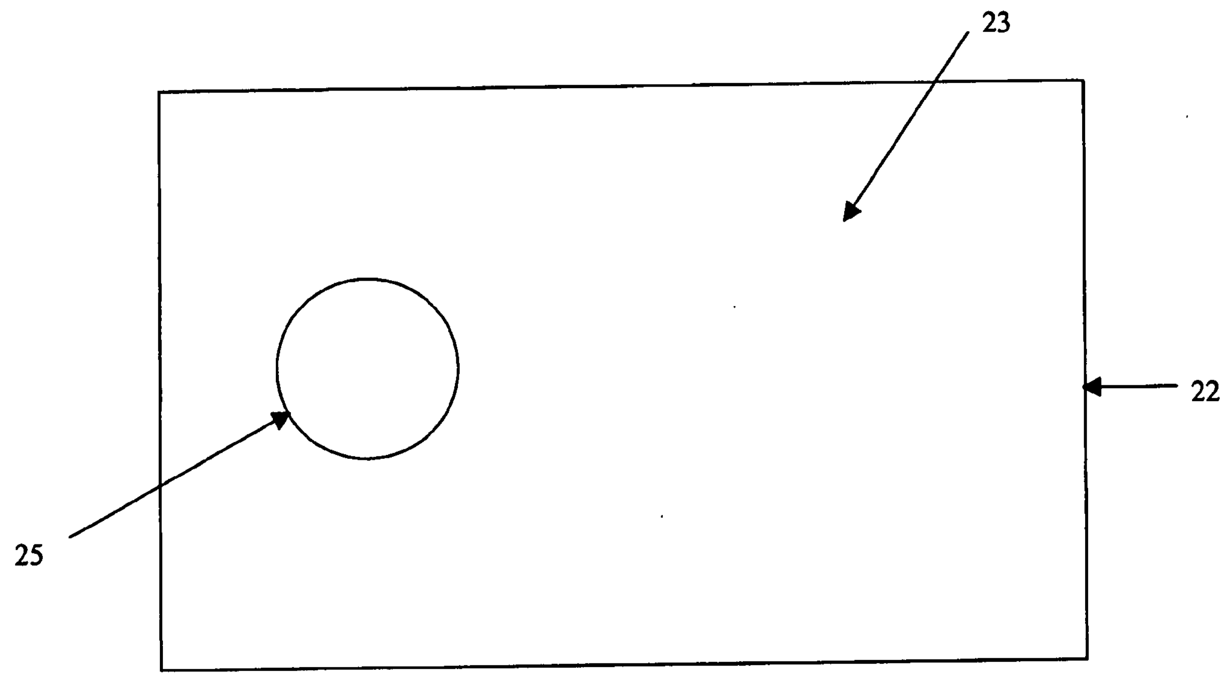

Fig. 3

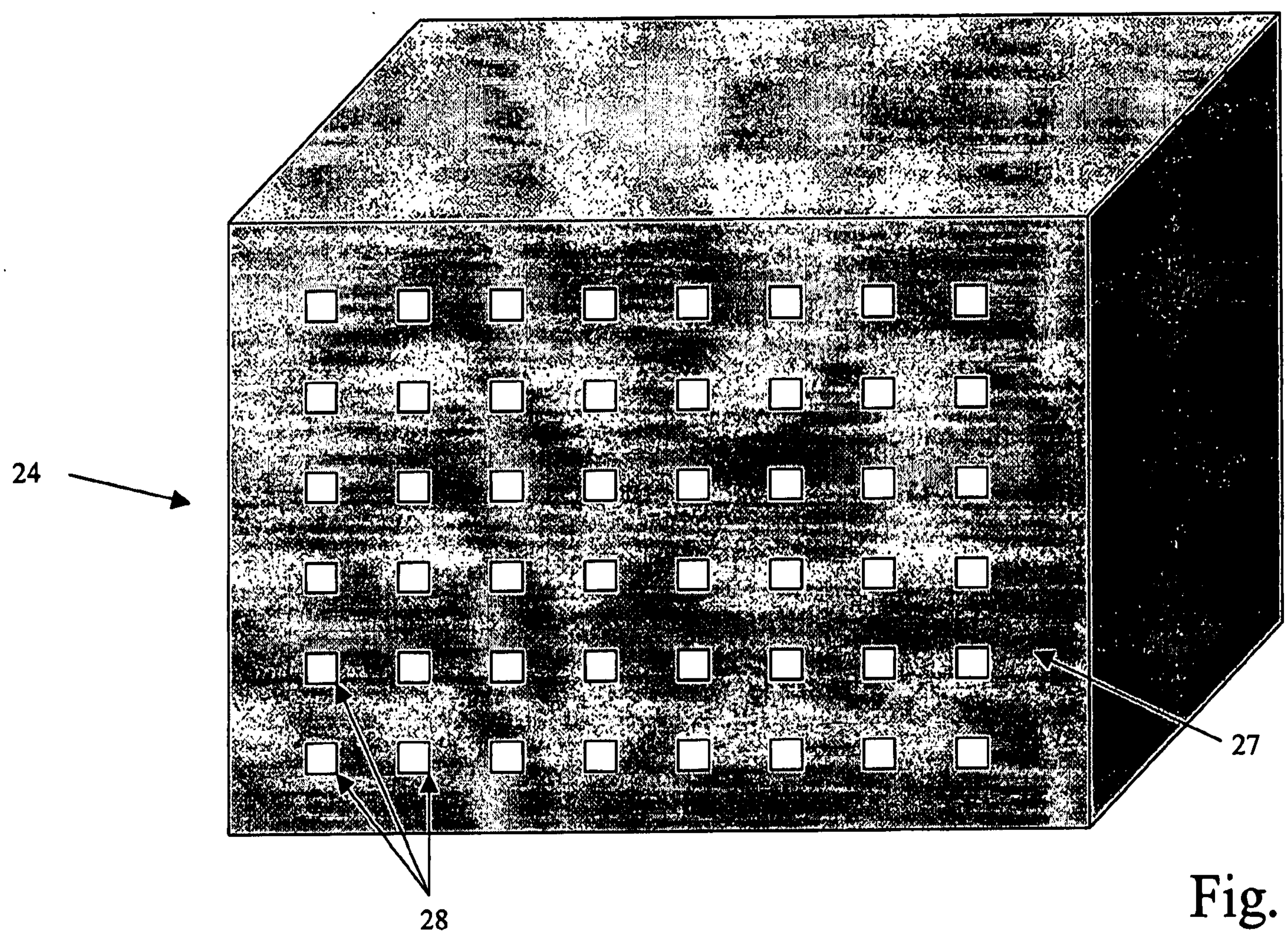

Fig. 4

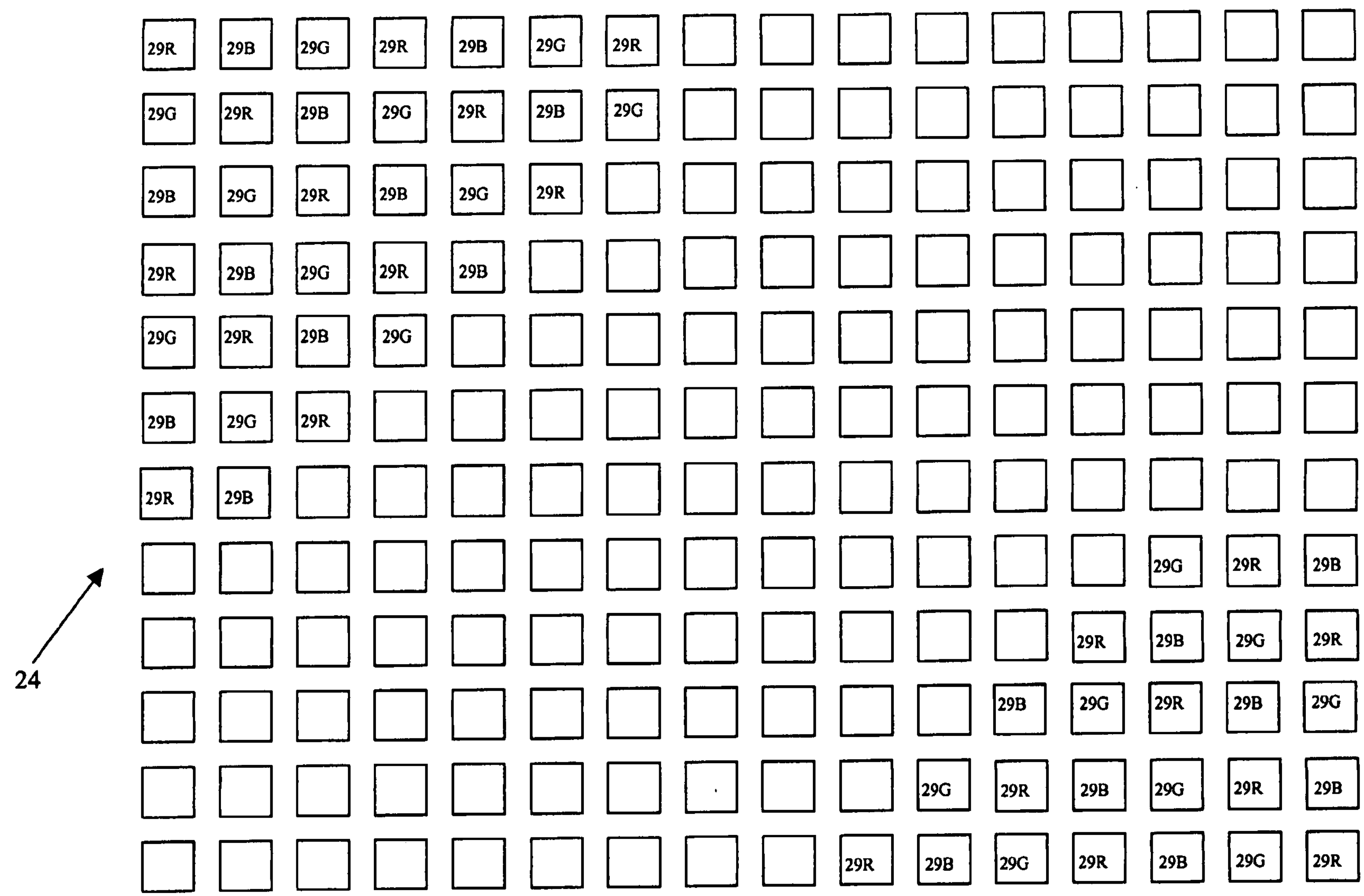
29R 29B 29G 29R 29B 29G 29R
29G 29R 29B 29G 29R 29B 29G
29B 29G 29R 29B 29G 29R
29R 29B 29G 29R 29B
29G 29R 29B 29G
29B 29G 29R
29R 29B
29G 29R 29B
29R 29B 29G 29R
29B 29G 29R 29B 29G
29G 29R 29B 29G 29R 29B
29R 29B 29G 29R 29B 29G 29R
24

Fig. 5

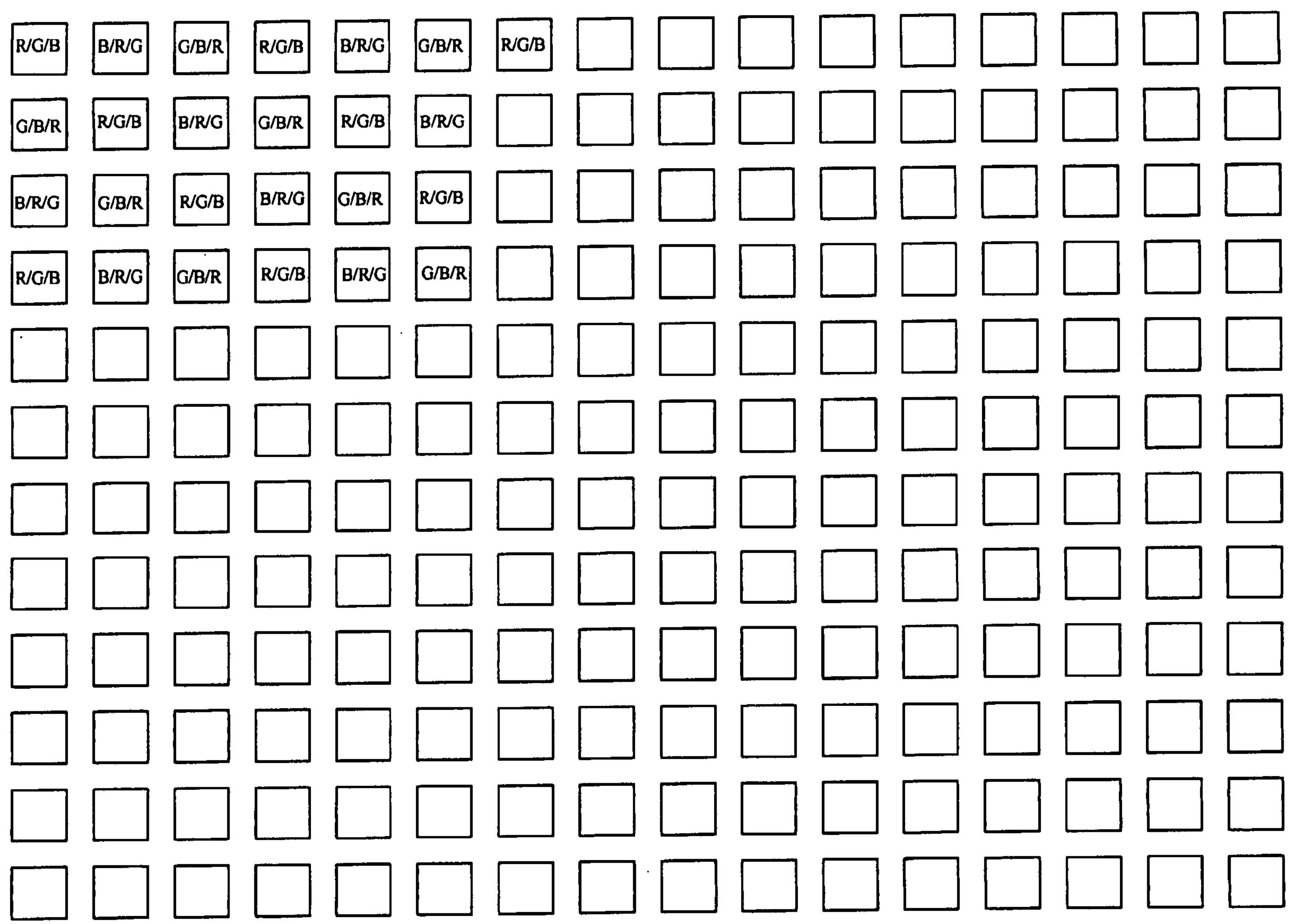
R/G/B B/R/G G/B/R R/G/B B/R/G G/B/R R/G/B
G/B/R R/G/B B/R/G G/B/R R/G/B B/R/G
B/R/G G/B/R R/G/B B/R/G G/B/R R/G/B
R/G/B B/R/G G/B/R R/G/B B/R/G G/B/R

Fig. 6

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/US04/034270

International filing date: 15 October 2004 (15.10.2004)

Document type: Certified copy of priority document

Document details: Country/Office: US
Number: 60/511,872
Filing date: 16 October 2003 (16.10.2003)

Date of receipt at the International Bureau: 29 November 2004 (29.11.2004)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)

World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse